Attorney's Docket No.: 06618/662001 / CIT 3252

REMARKS

Reconsideration and allowance of the above referenced application are respectfully requested.

A new declaration will be submitted in due course.

The drawings stand objected to due to informalities. A drawing change is submitted herewith which obviates many of the rejections. Only those items which are not changed responsive to the rejection are referred to herein.

In figure 3B, the PSP had a reference designation 312. Similarly, in figure 3C, the nitride already had the reference designation 320. 323 refers to the area where the substrate increases in height, and this is clear from the figure. However, since this is shown more clearly in figure 3D, the reference designation has been moved to that Figure.

In figure 3F, the aluminum contact is shown within the hole 352.

Figure 10A-10F show an alternative fabrication process. This is explained in the specification on page 14.

Figure 10D does in fact show multiple silicon nitride layers as described. Figure 13 shows a cross-sectional area of specified locations in figure 12. The unlabeled arrows refer to the cross-sectional indications. This has been added to figure

12.

Multiple claims stand rejected based on 35 USC 112, second paragraph, as allegedly being indefinite. In response, the claims are amended herewith for definiteness.

The claims stand rejected under 35 USC 103 as allegedly being unpatentable over Seefeldt in view of Sparks and Buhl. This contention is respectfully traversed, and it is respectfully suggested that the rejection does not meet the patent office's burden of providing a prima facie showing of unpatentability.

Specifically, claim 1 specifies a surface micromachined pressure sensor that is capable of sensing pressures that are greater than 6000 P.S.I. This is simply unheard of in the prior art, and it is respectfully suggested that the rejection does not show anything that could sense such a high pressure.

'430 teaches a system with a force transducer formed from a silicon diaphragm. In the absence of any other teaching, the silicon diaphragm could break under high pressures. There is no teaching of anything that could prevent the silicon diaphragm from breaking when placed into a high pressure situation. Accordingly, it is respectfully suggested that Seefeldt '430 would not be capable of being used in such a high pressure, and that '430 would not be "capable of sensing pressures that are

greater than 6000 P.S.I." as claimed. Therefore, it is respectfully suggested that the rejection does not meet the patent office's burden of providing a prima facie showing of unpatentability. Claim 1 should be allowable along with the claims which depend therefrom. Specifically, claim 10 specifies the vacuum cavity having a depth that is based on over pressure protection characteristics. This enables the device to be used at very high pressures, and this is in no way taught or suggested by the cited prior art.

Claim 12 specifies an additional resistor which is sized to compensate for offset voltage. This is formed on a dummy diaphragm. Once again, none of this is in any way toward or suggested by the cited prior art.

New claims 65 and 66 also specify the overpressure protection part which is in no way taught or suggested by the cited prior art, and which should be further allowable thereover.

Claim 33 teaches a Micro sized pressure sensor which is capable of sensing high temperatures similar to those discussed above. Hence, this claim should be allowable for similar reasons to those discussed above. In addition, however, this claim teaches that the size of the device is less than 100 microns from edge to edge. There is no showing in any of the

references that they are capable of forming such a Micro sized device. Therefore, claim 33 should be allowable along with the claims which depend therefrom. Claims 41 and 42 should be allowable for similar reasons to those discussed above with respect to claims 10 and 11.

Claim 60 should be allowable for entirely different reasons. Claim 60 reads on the embodiment of figures 12 and 13, and accordingly defines that the diaphragm is that connected "at least around a perimeter thereof to said substrate, with a perimeter less than 100 microns. The cited prior art does not teach these features. Claim 61 specifically defines an extending portion at an area near a center of the diaphragm forming the doughnut shape seen in figures 12 and 13. This is in no way taught or suggested by the cited prior art, and should be even further allowable.

In view of the above amendments and remarks, therefore, all of the claims should be in condition for allowance. A formal notice to that effect is respectfully solicited.

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Respectfully submitted,

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Attached is a marked-up version of the changes being made by the current amendment.

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Version with markings to show changes made

In the specification:

Please replace the paragraph beginning at page 4, paragraph number [0023] with the following rewritten paragraph:

Figure 1 shows a cross-section of the surface micromachined piezoresistive high-pressure sensor according to an embodiment. Strain sensitive resistors 102, such as polysilicon piezoresistors, may be placed in a location where they are sensitive to the strain caused by diaphragm movement. Other materials, such as platinum, can also be used. In a cross-section, strain sensitive resistors 102, 104 are shown within a diaphragm 106, that is formed of a flexible material. That material may be silicon nitride.

Please replace the paragraph beginning at page 10, paragraph number [0038] with the following rewritten paragraph:

In figure 3D, the sacrificial layer, here PSG and silison dioxide layer 310, may be removed using a 49 percent HF solution to release the silicon nitride diaphragm. After etching away the sacrificial/PSG layer, the cavity height will be decreased by about 10% due to the tensile stress of the LPCVD silicon nitride. This also leaves a vacuum chamber 331. This decrease may also be considered when optimizing the design.

Please replace the paragraph beginning at page 10, paragraph number [0041] with the following rewritten paragraph:

In figure [3C] 3E, the polysilicon films 340, which will form the strain sensitive resistors, are deposited. There films may be 5000 angstroms in thickness. The films may be deposited, doped, and patterned to form the eventual sensing resistors. Each of the polysilicon films may be doped twice.

Please replace the paragraph beginning at page 11, paragraph number [0046] with the following rewritten paragraph:

Figure 6 shows further details of the device. The temperature sensor includes a polysilicon thermistor 600 used for temperature compensation. Four silicon nitride diaphragms 500, 502, 504, 506 may be used. The multiple diaphragm configuration may be used to avoid the self-heating effect. Self heating may be due to the small diaphragm size, and thermal isolation within the vacuum cavity. Strain sensitive resistors 605 are allocated among the multiple diaphragms to increase the resistance and thereby decrease the total power consumed. Moreover, the power may be dissipated over a larger area to further reduce the power density. In an embodiment, half of the polysilicon resistors may be formed on the silicon nitride

diaphragm, with the other half being formed on the silicon nitride diaphragm, with the other half being formed on the silicon substrate.

Please replace the paragraph beginning at page 12, paragraph number [0047] with the following rewritten paragraph:

Figure 6 shows the piezoresistors arranged as a Wheatstone bridge, with some of the resistors 615, 618 on the substrate, and others of the resistors 616, 617 on the diaphragm. This may be formed by resistors which are on the diaphragms, and to other resistors which are off of the diaphragms, e.g. on the substrate.

Please replace the paragraph beginning at page 13, paragraph number [0049] with the following rewritten paragraph:

As the size of the diaphragm increases, the inventor found that cracks 800 may occur at boundaries of the diaphragm. These cracks may be especially problematic at areas of the edges of the sacrificial layer especially at areas of the bird's beak 805. For example, figure 8 shows how cracks may occur at those edge areas.

In the claims:

Please amend the claims as follows:

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1. A device, comprising:

a substrate; and

a surface micromachined pressure sensor, formed on said substrate, and formed to be capable of sensing pressures that are greater than 6000 psi.

2. A device as in claim 1, wherein said pressure sensor includes at least a plurality of strain sensitive resistors.

3. A device as in claim 2, wherein said strain sensitive resistors are arranged into a Wheatstone bridge.

4. A device as in claim 2, wherein said strain sensitive resistors are formed of deposited polysilicon.

5. A device as in claim 2, wherein said surface micromachined pressure sensor includes a diaphragm layer, formed from a silicon nitride layer.

6. A device as in claim 5, wherein said strain sensitive resistors are buried in said silicon nitride layer.

7. A device as in claim 1, wherein said pressure sensor

includes a diaphragm material, formed of a material with fracture strain greater than a predetermined amount, and Young's modulus greater than a predetermined amount, and a plurality of strain sensitive resistors, formed in said diaphragm material.

8. A device as in claim 7, wherein said strain sensitive resistors are piezoresistors.

9. A device as in claim 1, wherein said surface micromachined pressure sensor is capable of sensing pressures greater than or equal to 10,000 PSI.

10. A device as in claim 8, further comprising a vacuum cavity, under said diaphragm material, said cavity having a depth that is based on overpressure protection characteristics.

11. A device as in claim 10, wherein said depth of said cavity is substantially equal to an amount of deflection of the diaphragm at a specified maximum pressure.

12. (Amended) A device as in claim 5, further comprising at least one additional resistor, formed on [a device] <u>an area</u> other than said diaphragm layer, but formed on said substrate,

said at least one additional resistor being sized to compensate for an offset voltage.

13. A device as in claim 12, wherein said surface micromachined pressure sensor includes a diaphragm, and further comprising a dummy diaphragm having at least one similar characteristic to said diaphragm.

14. A device as in claim 13, wherein said at least one additional resistor is formed on said dummy diaphragm.

15. A device as in claim 2, wherein said resistors are deposited polysilicon.

16. A method, comprising:

forming a trench in a semiconductor material;

filling said trench with a sacrificial material;

covering said sacrificial material with at least one diaphragm layer, having a Young's modulus which is effective to allow said at least one diaphragm layer to deform by an amount without being damaged and to withstand at least 6000 P.S. I.; and

removing said sacrificial material to leave a cavity

beneath said diaphragm layer.

17. A method as in claim 16, wherein there are at least two of said diaphragm layers, and further comprising forming at least one strain sensitive resistors between said at least two diaphragm layers.

18. A method as in claim 16, wherein said strain sensitive resistor is a piezoresistor.

19. A method as in claim 18, wherein said piezoresistor is formed of polysilicon.

20. A method as in claim 17, further comprising at least one additional covering layer, also formed of a diaphragm-capable material, and at least one hole formed in said additional covering layer, in an area of said strain sensitive resistor area.

21. A method as in claim 20, further comprising depositing a metal material in said hole, acting as a contact to said strain sensitive resistor.

22. A method as in claim 17, wherein at least one of said diaphragm layers are formed of a silicon nitride material.

23. A method as in claim 22, wherein said sacrificial layer includes a phosphosilicate glass material.

24. A method as in claim 22, wherein said sacrificial layer includes a grown silicon dioxide material.

25. A method as in claim 16, wherein said filling comprises forming a thermal silicon dioxide within said trench.

26. A method as in claim 25, wherein said removing comprises using an acid solution to remove the thermal oxide.

27. A method as in claim 25, further comprising, after said filling, planarizing a layer comprising said at least one diaphragm material.

28. A device as in claim 7, wherein said strain sensitive resistors have a size less than one third of a radius of said diaphragm.

29. A device as in claim 1, wherein said substrate is formed of a semiconductor material.

30. A device as in claim 5, wherein said diaphragm layer is formed of a plurality of separated layers.

31. A device as in claim 30, wherein each of said separated layers are formed of silicon nitride.

32. A device as in claim 30, wherein at least one of said separated layers is formed of silicon nitride, and one of said separated layers is formed of polysilicon.

33. (Amended) A device, comprising:

a substrate; and

a surface micromachined pressure sensor, having a deformable membrane formed adjacent said substrate, said membrane having an outer size from edge [into the other] to edge which is less than 100 microns, and having a thickness that is capable of withstanding a pressure that is greater than at least 6000 psi.

34. A device as in claim 33, further comprising a

plurality of strain sensitive resistors, formed within said membrane.

35. A device as in claim 33, wherein said surface micromachined pressure sensor elements includes a silicon nitride layer.

36. A device as in claim 35, wherein said membrane is formed of a plurality of layers.

37. A device as in claim 36, wherein each of said plurality of layers includes silicon nitride.

38. A device as in claim 36, wherein at least one of said plurality of layers includes silicon nitride, and another of said layers includes polysilicon.

39. A device as in claim 33, wherein said membrane has a thickness that allows it to withstand a pressure of at least 10,000 P.S.I.

40. A device as in claim 33, wherein said membrane is attached to said substrate along an outer periphery thereof, and

also at a center thereof.

41. A device as in claim 33, further comprising a vacuum cavity, under said diaphragm material, said cavity having a depth that is based on desired overpressure protection characteristics.

42. A device as in claim 41, wherein said depth of said cavity is substantially equal to an amount of deflection of the diaphragm at a specified maximum pressure.

43. (Amended) A device as in claim [33] 34, further comprising at least one additional resistor, formed on a device other than said membrane, but formed on said substrate, said at least one additional resistor being sized to compensate for an offset voltage.

44. A device as in claim 34, wherein said resistors are formed of polysilicon.

45. A device as in claim 34, wherein said resistors are formed of platinum.

46. A device as in claim 33, further comprising a capacitive sensor, sensing an amount of deflection of said diaphragm.

47. A method as in claim 23, further comprising reflowing said PSG material to smooth a shape of edges thereof.

48. A method as in claim 23, further comprising forming at least one additional diaphragm to compensate for at least one error in sensing.

49. A method as in claim 48, wherein said at least one error is the self heating effect.

50. A method as in claim 48, wherein said at least one error is an offset voltage.

51. A method, comprising:

forming a layer of sacrificial material on a substrate material, said sacrificial material comprising a glass material that can be reflowed by heating;

heating said sacrificial material layer to reflow said sacrificial layer material and to smooth edges thereof;

forming a layer of diaphragm material, of the silicon nitride material, over said sacrificial layer; and

removing said sacrificial layer to release said diaphragm and form a cavity under said diaphragm.

52. A method as in claim 51, wherein said sacrificial material has a thickness based on a maximum pressure capability of said diaphragm.

53. A method as in claim 52, wherein said maximum pressure capability is at least 6000 P.S.I.

54. A method as in claim 51, further comprising forming at least one strain sensitive resistors in said diaphragm.

55. A method as in claim 54, wherein said forming comprises forming said strain sensitive resistors of polysilicon.

56. A method as in claim 54, wherein said forming comprises forming said strain sensitive resistors of platinum.

57. A method as in claim 51, wherein said forming a layer

of diaphragm material comprises forming a layer which is sufficiently thick to withstand at least 6000 P.S.I.

58. A method as in claim 57, wherein said forming a layer of diaphragm material comprises forming a plurality of layers of diaphragm material, at least one of said layers formed of said silicon nitride material.

59. A method as in claim 58, wherein at least one other layer is formed of polysilicon.

60. A device, comprising:

a substrate;

a deformable diaphragm, coupled to said substrate, and connected at least around a perimeter thereof to said substrate, and separated from said substrate to form a cavity under said diaphragm between said diaphragm and said substrate, said deformable diaphragm having an outer perimeter size which is less than 100 microns, and having a thickness which is greater than three microns.

61. A device as in claim 60, wherein said substrate includes an extending portion at an area near a center of said

diaphragm, and wherein said diaphragm portion is also connected to said extending portion.

62. A device as in claim 60, wherein said diaphragm is formed of a plurality of layers.

63. A device as in claim 62, wherein at least one of said layers is formed of silicon nitride.

64. A device as in claim 63, wherein at least one of said layers is formed of polysilicon.

Kindly add the following new claims.

65. (New) A device as in claim 1, further comprising an ~~and~~ over pressure protection part, integral with said device, and protecting said device against pressures which are higher than adesigned-for amount.

66. (New) A device as in claim 65, further comprising a diaphragm layer, and a vacuum chamber under said diaphragm layer, and wherein said over pressure protection part is formed by a depth of said vacuum chamber which limits an allowable deflection of said diaphragm layer.

67. (New) A device as in claim 65, further comprising a diaphragm layer, and a vacuum chamber under said diaphragm layer, with a post in a substantially central area of said vacuum chamber, limiting a deflection of said diaphragm layer.